

Curriculum Vitae

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Born: 6 March 1965 in Clearwater, Florida

Education: Ph.D., Astronomy, Yale University, 1994
M.Phil., Astronomy, Yale University, 1989
M.S., Astronomy, Yale University, 1988
B.A., Physics, New College of USF, 1987

Ph.D. Dissertation: Title: An Observational Study of Galaxies and their Environment on Large Scales
Advisor: Augustus Oemler, Jr.
Importance: First results from the Las Campanas Redshift Survey

Experience: 1996 – present: Applications Physicist,
Experimental Astrophysics Group,
Fermi National Accelerator Laboratory
1994 – 1996: Postdoctoral Researcher,
Astrophysikalisches Institut Potsdam (Germany)
1987 – 1994: Research Assistant, Yale University
1988 – 1993: Teaching Assistant, Yale University
1987: Research Assistant, New College of USF

Research Interests: Sloan Digital Sky Survey (SDSS),
SuperNova Acceleration Probe (SNAP),
Dark Energy Survey (DES),
Las Campanas Redshift Survey (LCRS),
Groups of Galaxies, Large Scale Structure,
Precision Stellar Photometry

Current Responsibilities: SDSS Monitor Telescope Pipeline
SDSS Photometric Telescope data processing and QA
SNAP photometric calibrations (team member)
SNAP Calibration Team/SNAP Simulations Team liaison
Dark Energy Survey photometric calibrations (with J. Annis)

Software Environments: Tcl/Astrotools (SDSS), Java, Fortran, MySQL, IRAF,
UNIX/Linux, VAX VMS

Professional Societies: American Astronomical Society
Astronomical Society of the Pacific

References

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Bibliography

Ten Career-Defining Publications

- Shectman S.A., Landy S.D., Oemler A., **Tucker D.L.**, Lin H., Kirshner R.P., Schechter P.L. 1996, "The Las Campanas Redshift Survey," *The Astrophysical Journal*, 470, 172
- Tucker D.L.**, Oemler A., Kirshner R.P., Lin H., Shectman S.A., Landy S.D., Schechter P.L., Müller V., Gottlöber S., Einasto J. 1997, "The Las Campanas Redshift Survey Galaxy-Galaxy Autocorrelation Function," *The Monthly Notices of the Royal Astronomical Society*, 285, 5P
- Allam S.S., **Tucker D.L.**, Lin H., Hashimoto Y. 1999, "Star Formation in Las Campanas Compact Groups," *The Astrophysical Journal (Letters)*, 522, L92
- Tucker D.L.**, Oemler A., Hashimoto Y., Shectman S.A., Kirshner R.P., Lin H., Landy S.D., Schechter P.L., Allam, S.S. 2000, "Loose Groups of Galaxies in the Las Campanas Redshift Survey," *The Astrophysical Journal (Supplement)*, 130, 237
- Smith J.A., **Tucker D.L.**, Kent S., et al. 2002, "The Sloan Digital Sky Survey: The $u'g'r'i'z'$ Standard Star System," *The Astronomical Journal*, 123, 2121
- Stoughton C., Lupton R. H., Bernardi M., et al. 2002, "Sloan Digital Sky Survey: Early Data Release," *The Astronomical Journal*, 123, 485
- Einasto J., Hütsi G., Einasto M., Saar E., **Tucker D. L.**, Müller V., Heinämäki P., Allam S. S. 2003, "Clusters and superclusters in the Sloan Digital Sky Survey," *Astronomy & Astrophysics*, 405, 425
- Lee B. C., Allam S. S., **Tucker D. L.**, et al. 2004, "A Catalog of Compact Groups of Galaxies in the SDSS Commissioning Data," *The Astronomical Journal*, 127, 1811
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- Rider C. J., **Tucker D. L.**, Smith J. A., Stoughton C., Allam S. S., Neilsen E. H. 2004, "A Survey of Open Clusters in the $u'g'r'i'z'$ Filter System. I. Results for NGC 2548 (M48)," *The Astronomical Journal*, 127, 2210

Refereed Publications

- Kazaks P.A., **Tucker D.L.** 1988, "Geometry of Spin Effects in Proton-Proton Scattering," *Physical Review D*, 37, 222
- Doroshkevich A.G., **Tucker D.L.**, Oemler A., Kirshner R.P., Lin H., Shectman S.A., Landy S.D., Fong R. 1996, "Large- and Superlarge-Scale Structure in the Las Campanas Redshift Survey," *The Monthly Notices of the Royal Astronomical Society*, 283, 1281
- Hamuy M, Phillips M.M., Suntzeff N.B, et al. 1996, "BVRI Light Curves for 29 Type Ia Supernovae," *The Astronomical Journal*, 112, 2408
- Landy S.D., Shectman S.A., Lin H., Kirshner R.P., Oemler A., **Tucker D.** 1996, "The 2-Dimensional Power Spectrum of the Las Campanas Redshift Survey: Detection of Excess Power on $100 h^{-1}$ Mpc Scales," *The Astrophysical Journal (Letters)*, 456, L1
- Lin H., Kirshner R.P., Shectman S.A., Landy S.D., Oemler A., **Tucker D.L.**, Schechter P.L. 1996, "The Luminosity Function of Galaxies in the Las Campanas Redshift Survey," *The Astrophysical Journal*, 464, 60
- Lin H., Kirshner R.P., Shectman S.A., Landy S.D., Oemler A., **Tucker D.L.**, Schechter P.L. 1996, "The Power Spectrum of Galaxy Clustering in the Las Campanas Redshift Survey," *The Astrophysical Journal*, 471, 617
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- Lee B. C., Allam S. S., **Tucker D. L.**, et al. 2004, "A Catalog of Compact Groups of Galaxies in the SDSS Commissioning Data," *The Astronomical Journal*, 127, 1811
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- Tegmark M., Strauss M. A., Blanton M. R., et al. 2004, "Cosmological parameters from SDSS and WMAP," *Physical Review D*, 69, 103501
- Abazajian K., Adelman-McCarthy J. K., Agüeros M. A., et al. 2004, "The Second Data Release of the Sloan Digital Sky Survey," *The Astronomical Journal*, 128, 502
- Finkbeiner D. P., Padmanabhan N., Schlegel D. J., et al. 2004, "Sloan Digital Sky Survey Imaging of Low Galactic Latitude Fields: Technical Summary and Data Release," *The Astronomical Journal*, 128, 2577

Conference Publications

- Kirshner R.P., Oemler A., Schechter P.L., Shectman S.A., **Tucker D.L.** 1991, “The Las Campanas Deep Redshift Survey,” in *Physical Cosmology*, eds. A. Blanchard, L. Celnikier, M. Lachièze-Rey, and J. Trân Thanh Vân, (Gif-sur-Yvette, France: Éditions Frontières), p. 594.
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- Lin H., Kirshner R.P., Shectman S.A., Landy S.D., Oemler A., **Tucker D.L.**, Schechter P.L. 1994, “The Power Spectrum of Galaxy Clustering in the Las Campanas Fiber-Optic Redshift Survey,” *Bulletin of the American Astronomical Society*, 26, 1408 (abstract — poster)
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- Smith J.A., McKay T.A., Brinkmann J., McMillan R., Briggs J.W., **Tucker D.L.**, Doi M., Hamabe M., Ichikawa S., Watanabe M., Ichikawa T., Richmond M.W., Fukugita M., Kron R.G., Gunn J., Rockosi C.M., Annis J., Kent S., Uomoto A. 1997, “Plans for Photometric Calibration of the Sloan Digital Sky Survey,” *Bulletin of the American Astronomical Society*, 29, (abstract — poster)
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Seminar & Colloquium Talks

Astronomical Institute of the Romanian Academy, in Bucharest, Romania, June 1990.

Union College, in Schenectady, New York, April 1994.

Space Telescope Science Institute, in Baltimore, Maryland, April 1994.

Universität Göttingen, in Göttingen, Germany, May 1995.

University of Durham, in Durham, England, October 1995.

Copenhagen University, in Copenhagen, Denmark, October 1995.

New College of USF, in Sarasota, Florida, January 1996.

Jagiellonian University, Krakow, Poland, March 1996.

Max-Planck-Institut für Astronomie, in Heidelberg, Germany, May 1996.

Osservatorio Astronomico di Capodimonte, in Naples, Italy, May 1996.

Istituto Nazionale di Fisica Nucleare/Sezione di Perugia, in Perugia, Italy, May 1996

Università Roma La Sapienza, in Rome, Italy, May 1996

New Mexico State University, in Las Cruces, New Mexico, February 1999

Tartu Observatory, in Toravere, Estonia, June 1999

Fermilab, in Bataiva, Illinois, October 1999 (Naperville and Peoria Astronomical Societies)

Rochester Institute of Technology, in Rochester, New York, November 1999

Fermilab, in Bataiva, Illinois, November 2002 (Skokie Astronomy Club)

Georgia Southern University, in Statesboro, Georgia, October 2003

Fermilab, in Bataiva, Illinois, November 2003 (Notre Dame Physics Club)

Teaching Goals and Philosophy

Astronomy enjoys a broad appeal. Furthermore, many of its modern discoveries are accessible to the intelligent layperson, which makes introductory astronomy courses popular to students of the humanities and social sciences. On the other hand, astronomy is a rigorous scientific discipline, of interest not only to those who choose astronomy as a career but also to science majors who desire a general knowledge of this branch of science. Therefore, astronomy serves as a bridge between the general public and the scientific community.

It is my desire to meet the needs of both the interested layperson and the career-oriented science major. Let us consider the needs of each in turn. First, the standard astronomical fare for the non-science major is a one- or two-semester general Introductory Astronomy course. This is indeed a tried-and-true method and is an important part of an astronomy course list, but I believe much more can be done. For instance, modern astrophysical discoveries could readily be incorporated into a “Modern Physics for Poets” course. Mathematically “soft” thematic, lab, and/or seminar courses are also a possibility. Regardless of the format, the aim of courses for non-science majors should be to teach the student the basics of astronomy and of scientific methodology. One acid test of success is that the student, after completing such a course, should be able to read a *Scientific American* article on the subject with a reasonable level of comprehension. Another test is that the student should be able afterwards to argue convincingly against the validity of various forms of “pseudo-science.”

On the other hand, the astronomy major requires — and the interested non-astronomy science major often desires — a rigorous program of mathematically intensive astrophysics. I would enjoy teaching a variety of courses for the science major. I would include among these a two-semester calculus-based sequence of Introductory Astronomy (using Shu or Abell as a primary text), an introductory or intermediate Observational Techniques course (using, among other texts, Henden & Kaitchuck), a semester- or year-long Stellar Physics course for sophomore- and junior-level students (with the Böhm-Vitense trilogy), a junior- or senior-level Cosmology course (Berry, Lachièze-Rey, Peebles, and/or others), and a junior- or senior-level Galaxies course (Mihalas & Binney; Combes, Boissé, Mazure, & Blanchard; Binney & Merrifield). The higher-level courses could also double as introductory graduate-level courses. To differing degrees, homework problem sets, student projects, and oral presentations would all play a part in each of these courses, with more emphasis being placed on projects and oral presentations in the upper-level courses. Outside of astronomy proper, I would also find teaching courses in Introductory Physics (Halliday & Resnick; Tipler), Statistics for Scientists and Engineers (Bevington), and Scientific Programming (various texts) of interest.

Past Research

1. The Las Campanas Redshift Survey (LCRS)

Most of my research until the year 2000 centered on the analysis of the LCRS (Shectman et al. 1996), a project which was first begun in the late-1980's by the team of Kirshner, Oemler, Schechter, and Shectman. (I joined the project as a graduate student in 1989.)

The LCRS is a survey of the galaxy distribution, out to a median redshift of $z_{\text{med}} \approx 0.1$, composed of six $1.5^\circ \times 80^\circ$ slices — three towards the North Galactic Cap and three towards the South. The original goals of the LCRS were to sample a large enough volume of the nearby Universe in order to constrain the scale of the largest features in the galaxy distribution and to use this sample for the accurate measure of galaxy clustering on a wide variety of scales. In the end, redshifts for $\sim 26,400$ galaxies were obtained, one of the largest galaxy redshift catalogues of its time. Perhaps the most important result from the LCRS is the visually striking evidence that the scale of homogeneity had at last been reached: the largest high-contrast coherent structures apparent in the slices were no larger than about $100h^{-1}$ Mpc across ($h \equiv H_0/100 \text{ km s}^{-1} \text{ Mpc}^{-1}$), even though much larger features — had they existed — would have been easily identifiable.

1.1. Large-Scale Structure in the LCRS

I have investigated several aspects of the large-scale structure within the LCRS, including the spatial autocorrelation function of galaxies (Tucker et al. 1997) and of loose groups of galaxies (Tucker 1994) and the dependence of galaxy type on environmental factors (Tucker et al. 1995). In collaboration with Andrei Doroshkevich of the Theoretical Astrophysics Centre (Denmark) and Dick Fong of the University of Durham (England), I have studied the mean free path between void walls ($\sim 80h^{-1}$ Mpc) and between filamentary structures ($\sim 15h^{-1}$ Mpc) (Doroshkevich et al. 1996). Doroshkevich, Fong, and I have also studied the three-dimensional properties of overdense regions within the LCRS using Minimal Spanning Tree techniques (Doroshkevich et al. 2001). In another collaboration, Jaan and Maret Einasto of Tartu Observatory (Estonia) and I extracted cluster and superclusters from the LCRS slices to study the effect on cluster properties by the supercluster environment (J. Einasto et al. 2003).

1.2. Loose Groups of Galaxies in the LCRS

Loose groups are intermediate in scale and environment between isolated galaxies and rich clusters, and thus they are interesting in the study of morphology-environment relations.

I have extracted a catalogue of 1495 loose groups from the LCRS (Tucker et al. 2000). This is one of the largest loose group catalogues in existence. Furthermore, since the LCRS is one of the first redshift surveys which can claim to enclose a reasonably fair sample of the nearby Universe, my loose group catalogue should contain a “fair sample” of loose groups which lie in a wide range of environments. (Most previous group catalogues have been based upon much shallower redshift surveys which are dominated by a very few large structures.) A census of group properties based upon LCRS groups is thus more complete, and therefore more useful for studies of both galaxy dynamics and environmental dependencies. In fact, this characteristic is so important that earlier variations of the present catalogue have already been used in studies of the environmental influence on galaxy morphology (Hashimoto et al. 1998), on the presence of “E+A” galaxies (Zabludoff et al. 1996), on the general rate of star formation within galaxies (Hashimoto et al. 1998, Allam et al. 1999), and on supercluster environments (M. Einasto 2003a,b).

1.3. Compact Groups of Galaxies in the LCRS

Compact groups of galaxies are defined by their small number of members (< 10), their compactness (typical intra-group separations of a galaxy diameter or less), and their relative isolation (intra-group separations \ll group-field separations); Stephan's Quintet is a beautiful and noteworthy example. They offer an exceptional laboratory for the study of dense galaxian environments with short (≤ 1 Gyr) dynamical timescales.

I have extracted 76 compact groups from the LCRS, and, in collaboration with Sahar Allam (visiting scientist at FNAL), I have studied the optical properties of these systems and the star formation properties of their member galaxies (Allam et al. 1999, Allam & Tucker 2000). I have also formed a collaboration — Hans Böhringer and Wolfgang Voges of the Max-Planck-Institut für Extraterrestrische Physik along with Sahar Allam — to study the x-ray properties of these compact groups. Interesting results from these studies include: (1) compact group galaxies show a deficit of star formation activity relative to loose group galaxies and to field galaxies, and (2) there is clear evidence of extended x-ray emission from hot gas from a significant fraction of LCRS compact groups.

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Current and Future Research

1. The Sloan Digital Sky Survey (SDSS)

The SDSS, which began in earnest in early-2000, will eventually image one-quarter of the entire sky in 5 filters ($u'g'r'i'z'$) down to a limiting magnitude of $r_{\text{lim}} \approx 23$. Within this bonanza of data will be photometry for $\sim 10^8$ stars, galaxies, and quasars. Followup spectroscopy will eventually yield spectra for $\sim 10^6$ galaxies and $\sim 10^5$ quasars.

I have been deeply involved with the SDSS since 1996, and a large portion of my current and future research revolves around this enormous data set.

1.1. Compact Groups of Galaxies in the SDSS

I am presently working with Brian Lee (LBNL) and Sahar Allam in extracting a catalogue of compact groups of galaxies from the SDSS imaging data. We have already extracted 175 compact groups from 153 sq deg of early SDSS commissioning data (Lee et al. 2004). Eventually, we hope to extract $\sim 10,000$ compact groups from the full SDSS photometric catalogue; the resulting catalogue should be roughly volume-limited and have a median redshift of $z_{\text{med}} \sim 0.1$. Thus, this catalogue will eventually be three times deeper and contain perhaps 100 times more compact groups than the venerable Hickson Compact Group catalogue. The SDSS compact group catalogue will be useful for studies of large-scale structure and of morphology-environment relations.

1.2. Merging Pairs of Galaxies in the SDSS

I am also working with Sahar Allam on producing a catalogue of merging pairs of galaxies from the SDSS imaging data. Currently, we have extracted 1479 pairs of merging galaxies from 462 sq deg of SDSS Early Data Release photometry (Allam et al. 2004).

1.3. The SDSS Standard Star Network

Most of my work on the SDSS has dealt with the trio of support telescopes used by the SDSS for setting up the $u'g'r'i'z'$ standard star network (the USNO 1m at Flagstaff), for monitoring nightly extinction (the now-retired 0.6m Monitor Telescope at Apache Point Observatory and its replacement, the 0.5m Photometric Telescope), and for obtaining a set of ~ 1500 transfer fields to calibrate the photometry from the SDSS 2.5m telescope (the Photometric Telescope).

As a result of my efforts, I am the second author (out of an author list numbering 22) on the paper describing the network SDSS standard stars (Smith et al. 2002). Furthermore, in an independent project, J. Allyn Smith (LANL) and I have been extending the SDSS standard star network into the southern hemisphere; the observations for this project, which was granted ‘‘Survey Program’’ status by NOAO, have recently been completed and the analysis is underway. First results from this project have been published in Smith et al. (2003).

1.4. Star Clusters in the SDSS

J. Allyn Smith, Chris Stoughton (FNAL), and I have been working on a project using open clusters of stars to calibrate metallicity and age effects within stellar populations in the SDSS $u'g'r'i'z'$ filter system. To this end, dozens of star clusters which cover a range in both age and metallicity have been observed with the CTIO Curtis-Schmidt telescope and the USNO 1.0m telescope; these observations are being reduced through the SDSS support telescope pipeline, MTPIPE. So far, results for NGC 2548 (M48), NGC 6134, and Hogg 19 have been prepared by two undergraduate interns I mentored (Rider et al. 2004; Moore et al. 2005), and results for

NGC 1647 have been prepared by one of Smith's undergradates (Cantrell et al. 2005).

2. The SuperNova Acceleration Probe (SNAP)

The Supernova/Acceleration Probe (SNAP; <http://snap.lbl.gov>), a space mission planned for launch in 2012, will observe 2000 Type Ia supernovae out to a redshift of $z=1.7$ in order to measure accurately various cosmological parameters, including the Universe's mass density, vacuum energy density, curvature, and – most particularly – the equation of state of the Dark Energy driving the acceleration of the Universe. In order to accomplish this task, the supernova light curves must be accurately measured at a variety of wavelengths spanning the optical and near infrared. (Ideally, each supernova light curve will be measured in a redshifted B filter appropriate to its redshift; there will be 9 of these optical and near infrared filters.) Furthermore, the fluxes measured in the optical and in the near infrared must be well calibrated relative to each other

I am a member of the SNAP Calibration Team and am working on methods for successfully calibrating the SNAP mission.

3. The Dark Energy Survey (DES)

I have recently become involved in the photometric calibration of the Dark Energy Survey, a *griz* photometric survey of galaxies down to $i \approx 24$ over an area of 5000 sq deg in the Southern hemisphere. Observations for this survey are slated to begin in 2009 on the CTIO Blanco 4m telescope.

My main scientific interests in this project will be to study the evolution of galaxy properties and their environment as a function of redshift.

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